REMARKS

Claims 1-13 are currently pending in this application. No claims are amended herein. Claims 1-13 stand rejected under 35 U.S.C. § 103 as unpatentable over Ohashi ("Improved CIGS thin-film solar cells by surface sulfurization using In_2S_3 and sulfur vapor").

Applicants note that "[i]nherency, however, may not be established by probabilities or possibilities. The fact that a given thing *may* result from a given set of circumstances is not sufficient." *In re* Oelrich, 212 U.S.P.Q. 323, 326 (C.C.P.A. 1981). *See also* Tintec Industries, Inc. v. Top-USA Corp., 63 U.S.P.Q.2d 1597, 1599 (Fed. Cir. 2002). When relying upon the theory of inherency, the Examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic *necessarily flows* from the teachings of the applied prior art. *Ex parte* Levy, 17 U.S.P.Q.2d. 1461, 1464 (Bd. Pat. App. & Inter. 1990)(emphasis added).

The Examiner found that:

> Ohashi discloses the features including the claimed alloy composition and X-ray diffraction patterns (Figure 3 and section 3). Therefore, when prior art compounds essentially "bracketing" the claimed compounds in structural similarity are all known, one of ordinary skill in the art would clearly be motivated to make those claimed compounds in searching for new products in the expectation that compounds similar in structure will have similar properties. Office Action at page 3.

Applicants respectfully disagree. Ohashi does not disclose the claimed alloy. Although the post-sulfurization method of Ohashi and the method described in the present application can produce alloys that comprise the same chemical elements, for example Cu, In, Ga, Se, and S, the two alloys *are completely different*.

Ohashi clearly produces a heterogeneous alloy ("it was found that sulfur atoms substituted for selenium atoms. XRD (X-ray diffraction) patterns shown in Fig. 1(b) revealed that a $Cu(In,Ga)S,Se)_2$ *(CIGSS), which is a wider band-gap material, was formed at the surface of the CIGS thin films*." Emphasis added). The alloy formed in Ohashi comprises a *single alloy* comprising a CIGSS-surface layer superimposed on the CIGS-bulk of the body and not two separate alloys (i.e. CIGS and CIGSS).

The GIXRD-spectra depicted in Fig. 1(b) of Ohashi are not derived from separate CIGS and CIGSS alloys but from the single CIGS/CIGSS alloy that was formed via the post-sulfurization of the CIGS.

The Alloys of Ohashi are Heterogeneous

The Examiner also found that "arguendo the films are not homogenous, it is unclear how that would affect the recited properties." Office Action at page 4.

The technologies employed by Ohashi are based on the surface sulfurization of stable $Cu(In,Ga)Se_2$ thin films. In these typical post-sulfurization processes, the Se species at the surface region of the $Cu(In,Ga)Se_2$ bulk material are replaced with S species, resulting in the formation of a $Cu(In,Ga)(Se,S)_2$ surface layer in the near-surface region of the $Cu(In,Ga)Se_2$ bulk film. This reaction mechanism is governed by Fick's second law, i.e. the diffusion process is driven by concentration gradients between Se and S in the near-surface region.

The AES depth profiles in Figs. 1(a) and 3(b) of Ohashi reflect (i) the expected enrichment of the surface layer with sulfur and (ii) a systematic increase in the Ga concentration towards the Mo back contact, while the In concentration decreases in the same direction. The net result is a substantial variation in the Ga/In+Ga and S/Se+S atomic ratios through the film depth. Thus, the alloys of Ohashi are not homogenous based on the results of the AES depth profiling.
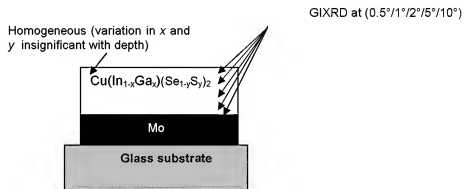
The lattice parameters of multinary alloys are controlled by the group III and group VI atomic ratios. Any significant change in the Ga/In+Ga and/or S/Se+S atomic ratios with sample depth would therefore result in a variation in the lattice parameters. The variation in elemental concentration (Cu, In, Ga, Se and S) with sample depth can be detected with AES, while the corresponding change in lattice parameters can be detected by GIXRD at a range of incidence angles.

There should be a direct correspondence between AES and GIXRD results. If AES measurements depict a substantial variation in the Ga/In+Ga and S/Se+S atomic ratios with sample depth, the corresponding GIXRD results should also reflect a substantial variation in lattice parameters.
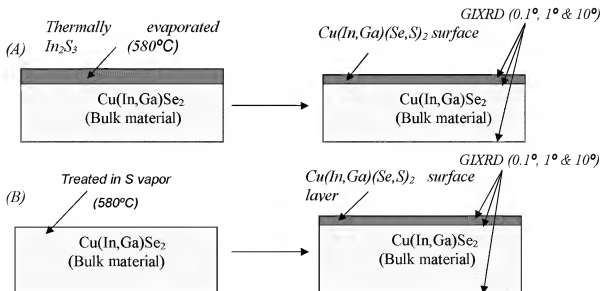
The GIXRD incidence angle determines the penetration depth of the measurement. For example, in CIGS alloys incidence angles of 0.5°, 1°, 2°, 5°, and 10° correspond to penetration depths of about 150 nm, 300 nm, 600 nm, 1500 nm, and 3000 nm, respectively.

In the case of GIXRD, an accurate estimate of the variation in lattice parameters with sample depth can only be achieved if a plurality of angles is considered (for example, angles of 0.5°, 1°, 2°, 5° and 10° were used to analyze the films in the specification of this application).

The recited properties and GIXRD measurement details of the product of the present application can be illustrated as follows:

GIXRD at (0.5°/1°/2°/5°/10°)

Homogeneous (variation in x and y insignificant with depth)

$Cu(In_{1-x}Ga_x)(Se_{1-y}S_y)_2$

Mo

Glass substrate

In contrast, Ohashi discloses Processes A and B for forming *heterogeneous* alloys in section 2 on page 262. Processes A and B can be schematically illustrated as follows:

(A) Thermally evaporated In_2S_3 (580°C)

$Cu(In,Ga)Se_2$ (Bulk material)

→

$GIXRD\ (0.1°,\ 1°\ \&\ 10°)$

$Cu(In,Ga)(Se,S)_2$ surface

$Cu(In,Ga)Se_2$ (Bulk material)

(B) Treated in S vapor (580°C)

$Cu(In,Ga)Se_2$ (Bulk material)

→

$GIXRD\ (0.1°,\ 1°\ \&\ 10°)$

$Cu(In,Ga)(Se,S)_2$ surface layer

$Cu(In,Ga)Se_2$ (Bulk material)

Ohashi only discloses *heterogeneous* pentenary alloys because CIGSS surface layers are formed on CIGS bulk material by exchanging Se with S. For the reasons discussed below, a heterogeneous alloy *cannot* produce an alloy with the recited properties and is different from the claimed alloy.

Heterogeneous Alloys Cannot Produce the Recited GIXRD Shift

The Examiner found that the GIXRD illustrated in Fig. 1(b) of Ohashi for CIGS (112) is clearly less than 0.06°. Office Action at pages 4-5. Applicant respectfully disagrees for the reasons discussed below.

The results illustrated in Fig. 3(a) of Ohashi cannot be considered in isolation. All aspects of the results presented in Ohashi along with the technical understanding of the skilled artisan should be considered. The GIXRD data shown in Ohashi is not consistent with the AES results. Figs. 1(b) and 3(a) of Ohashi are not sufficient to establish the in-depth compositional features of the alloys because of the restricted number of incident angles that fail to reflect variations in compositions (and hence lattice parameters) revealed by the corresponding AES results depicted in Figs. 1(a) and 3(b) of Ohashi.

Further, the GIXRD incidence angles at 1° and 10° provide very limited information and this result on its own is insufficient to describe the in-depth compositional uniformity of the alloys. This also explains the discrepancy between the XRD and AES results. In the case of AES the *entire depth of the sample was probed*, while the XRD results in Fig. 3(a) provides limited information from restricted regions in the samples. There should be a direct correspondence between AES and GIXRD results. The lattice parameters of multinary alloys are controlled by the group III and group VI atomic ratios. Any significant change in the Ga/In+Ga and/or S/Se+S atomic ratios with sample depth would therefore result in a variation in the lattice parameters. If AES measurements depict a substantial variation in the Ga/In+Ga and S/Se+S atomic ratios with sample depth, the corresponding GIXRD results should also reflect a substantial variation in lattice parameters. Fig. 1(a) of Ohashi shows that the Ga/In ratio varies continuously through the depth of the film. The Ga concentration decreases from about 10% at the Mo back contact to about 0% at the near-surface region of the film, while the In concentration continuously increases towards the surface of the CIGS film. The estimated net effect is a variation of about 25% in the

Ga/In+Ga atomic ratio. The variations in the Ga/In+Ga atomic ratio of about 25% would result in a shift of at least 0.25° in the GIXRD angles of the particular CIGS-film. Thus, the results of Ohashi do not disclose the recited GIXRD properties for at least this reason.

Moreover, the post-sulfurization process which is utilized by Ohashi is well-known and well documented in the art to form a heterogeneous alloy characterized by substantial mismatches in the lattice parameters.

Second, Applicant notes that the GIXRD results in Fig. 3(a) do not disclose data for glancing incidence angles over the full range of 0.2° to 10°. Fig. 3(a) of Ohashi only discloses x-ray diffraction data for incident angles of 0.1°, 1°, and 10°. For the alloys of Ohashi the 1° and 10° angles measure the bulk CIGS region of the alloys. The data from incident angles of 1° and 10° are not indicative of the range from 0.2° to 10° or composition of the entire alloy.

Third, to further support the deficiencies of the GIXRD data of the alloys of Ohashi, reference is made to an article entitled "A comparison of the material and device properties of homogeneous and compositional graded $Cu(In,Ga)(Se,S)_2$ chalcopyrite thin films", which was published by the Applicant in 2007 in Semiconductor Science and Technology, 22, 585. A copy is enclosed herewith. The compositional graded samples referred to in this article were prepared by a post-sulfurization method similar to that disclosed in Ohashi. These samples were provided by Shell Solar Industries. A schematic representation of the specific layer structure is given in Fig. 1(a), indicating the presence of the S enriched surface layer. The in-depth compositional properties of these samples were compared under identical GIXRD experimental conditions (radiation source, voltage, current and incident angles) with those of homogeneous CIGSSe films prepared according to the methods disclosed in Application Serial No. 10/568,227. The GIXRD patterns of the respective samples are shown in Figs. 3(b) and 5(b), respectively. Fig. 3(b) is illustrated below:
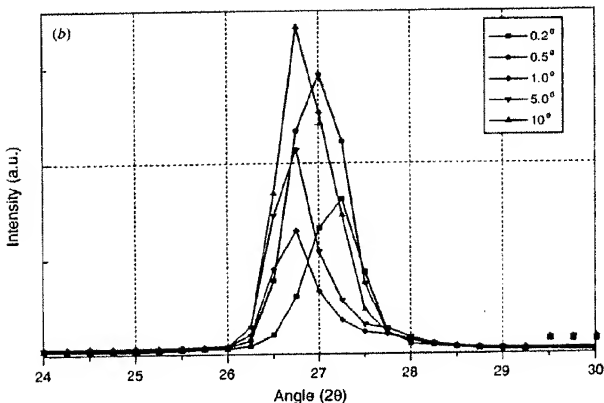
As shown in Fig. 3(b), the properties of the graded CIGSS films were evaluated over a range of incidence angles between 0.2° and 10°. For incidence angles of 1° and 10° the peaks overlap and have values close to 26.8°, which correspond to the peaks in Fig. 1(a) of Ohashi. However, at small incidence angles between 0.2° and 0.5° (not disclosed in Ohashi) the position of the [112] peak shifted to higher values between 27 and 27.2°, which is expected due to the replacement of Se with S in the near-surface region of the samples.

Accordingly, in view of the data in Fig. 3(b) one skilled in the art would conclude that the *heterogeneous* alloys of Ohashi *cannot* explicitly or inherently disclose an alloy with "a glancing incidence x ray diffraction pattern (GIXRD) for a glancing angle of from 0.2° to 10° reflects an absolute shift in the $2\theta_{(112)}$ angle of less than 0.06°" as claimed. Therefore, Applicant respectfully requests withdrawal of this rejection for at least this reason.

In conclusion, the Examiner has not provided a sufficient basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic *necessarily flows* from the teachings of the applied prior art. *Ex parte* Levy, 17 U.S.P.Q.2d. 1461, 1464 (Bd. Pat. App. & Inter. 1990)(emphasis added).

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Accordingly, the skilled artisan would appreciate that a heterogeneous alloy is not capable of producing an "alloy being characterized by an x-ray diffraction pattern (XRD) having a main [112] peak at a 2θ angle ($2\theta_{(112)}$) of from 26° to 28° for Cu radiation at 40kV, wherein a glancing incidence x ray diffraction pattern (GIXRD) for a glancing angle of from 0.2° to 10° reflects an absolute shift in the $2\theta_{(112)}$ angle of less than 0.06°" as recited in Claim 1. Thus, Ohashi fails to disclose the features of Claim 1 and its dependents. Accordingly, Applicant respectfully requests withdrawal of this rejection for at least this reason.

No reasonable expectation of success

Moreover, one skilled in the art would have no reasonable expectation of success for forming an alloy with the recited properties. *Pharmastem Therapeutics v. Viacell, Inc.* 491 F.3d 1342, 83 U.S.P.Q.2d 1289 (Fed. Cir. 2007) (after *KSR*, Federal Circuit finds claims non-obvious for lack of indication of reasonable expectation of success for asserted combination). Ohashi only discloses a two stage method for depositing the thin films. Ohashi fails to disclose how to overcome the problems known in the art with the two-stage process. There is no reason to deposit a film with the claimed features and no expectation of success to deposit a film with the claimed features by the methods disclosed in Ohashi. Further, the skilled artisan would have no reasonable expectation of success because the alloy formed in Ohashi is heterogeneous and would not be expected to produce the recited GIXRD pattern because of the heterogeneous composition and presence of multiple phases. This is not an obvious variation because "[t]o the extent that an art is unpredictable, as the chemical arts often are, *KSR*'s focus on these 'identified, predictable solutions' may present a difficult hurdle because potential solutions are less likely to be genuinely predictable." *Eisai Co. Ltd. v. Dr. Reddy's Laboratories, Ltd*, Nos. 2007-1397, -1398, slip opinion at pg 8 (Fed Cir. 2008). Again, there is no teaching or suggestion in Ohashi for how to overcome the problems known in the art with the two-stage method to achieve a film with the recited properties.

Dependent Claims

The Examiner further found the features of Claims 6-13 to be inherent, citing caselaw requiring that the claimed and prior art products be identical or substantially identical in structure

or composition, or be produced by identical or substantially identical processes. As discussed above, the products are not produced by the same methods and the products are clearly different. Accordingly, Applicant submits that the caselaw is not applicable to the current facts and that the Examiner has not met his burden to show that the features of even Claim 1 must necessarily flow from the cited references, as required.

The cited references also fail to disclose the features of the dependant claims. In particular, Ohashi fails to disclose or make obvious any of the recited variance in d-spacing values. Applicant notes that Ohashi fails to disclose any d-spacing values, much less "wherein the alloy has a crystal structure comprising a lattice of unit cells, wherein all crystallographic planes of the unit cells show a variance in d-spacing of less than 0.01Å" or "wherein the alloy has a crystal structure comprising a lattice of unit cells, wherein all crystallographic planes of the unit cells show a variance in d-spacing of less than 0.001Å" as recited in Claims 2 and 8, respectively. Also, these features are not inherent for the reason discussed above and there is no reason to modify to achieve the recited features or expectation of success. Accordingly, Applicant request that the rejections of Claims 2 and 8 be withdrawn for at least this reason.

Ohashi also fails to teach the features of Claim 3. Claim 3 recites in part "wherein the element concentration of elements A, B, C, D, and E, as characterized by XPS depth profiling, is substantially uniform through the alloy".

The Examiner found that substantially uniform XPS depth profiling read on the depth profiling of the cited reference. Applicants respectfully disagree because, as discussed above, Ohashi clearly discloses compositional gradients throughout the entire film. This is shown in the AES profiles for the alloys in Figs. 1(a) and 3(b). Therefore Ohashi fail to disclose this feature. Accordingly, Applicant request that the rejections of Claim 3 be withdrawn for at least this reason.

Additionally, Applicant submits that Claims 4-7 and 9-13 also define over the cited references, not only because they depend from Claim 1 but also on their own merit.

Request for rejoinder

Applicant submits that the claims are in condition for allowance. Claim 1 is currently generic. Upon allowance of a generic claim, Applicant respectfully requests rejoinder of withdrawn Claims 14-37.

No Disclaimers or Disavowals

Although the present communication may include characterizations of claim scope or referenced art, Applicant is not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any characterizations are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that Applicant has made any disclaimers or disavowals of any subject matter supported by the present application.

Co-Pending Applications of Assignee

Applicant wishes to draw the Examiner's attention to the following co-pending applications of the present application's assignee.

Docket No.	Serial No.	Title	Filed
DMKISCH.002APC	10/568,227	METHOD FOR THE PREPARATION OF GROUP IB-IIIA-VIA QUATERNARY OR HIGHER ALLOY SEMICONDUCTOR FILMS	May 17, 2006

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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